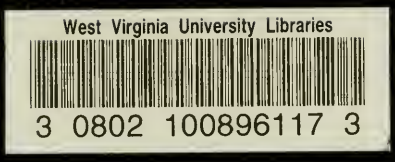
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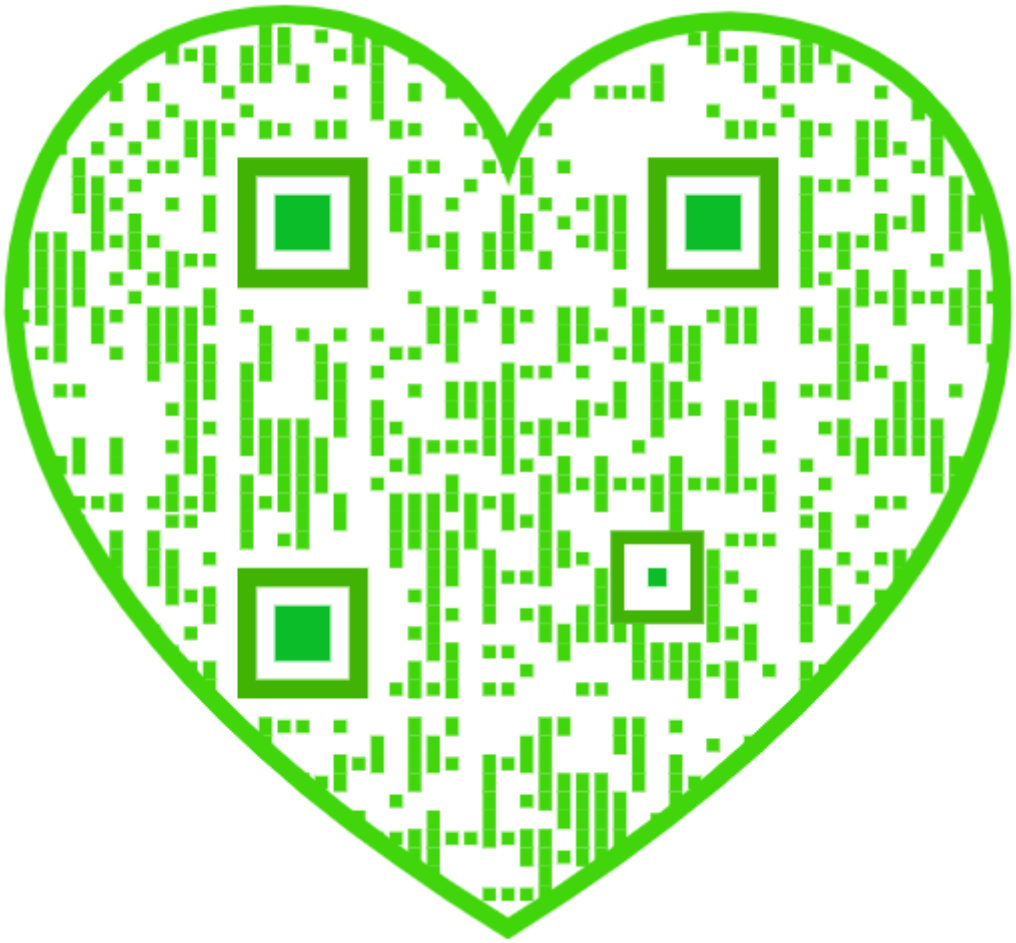

Bulletin 140 April, 1913

West Virginia University
Agricultural Experiment Station
MORGANTOWN, W. VA.

DEPARTMENT OF HORTICULTURE

Potato Culture in West Virginia

I. Possibilities as a Truck Crop.
II. Essentials of Culture.

By
ARTHUR L. DACY.

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BULLETIN 140

Potato Culture in West Virginia

By A. L. Dacy.

INTRODUCTION.

It is the object of this bulletin to direct the attention of our farmers to the possibilities of profit offered in the culture of the Irish potato as a truck crop for table use and for seed purposes.

The reasons for urging at this time an increased planting of this crop as well as the better care of the area usually planted to the same are: first, as will be pointed out in the following pages, there is a keen demand for the crop at remunerative prices which at present is by no means fully supplied by our farmers, and second, the potato is a crop that can be readily adapted to the systems of farming practiced in the state with benefit to the land.

In order to increase the interest already shown in the crop, and to answer the inquiries for information that are frequently received by the Station, the essential factors in the successful culture of the crop are briefly discussed.

Why West Virginia Farmers Should Grow More Potatoes.

The relative importance of the potato crop as compared with the other leading farm products of the state is brought out in the following table compiled from the figures of the United States Census of 1910.

TABLE I.—Relative Importance of West Virginia Crops. (13th Census.)

Crop.	Farms Reporting.	Acres Harvested.	Total Yield.	Total Value.	Average Yield Per Acre.	Average Value Per Acre.
Corn	83,028	676,311	17,119,097 lbs.	$11,907,261	25.3 bus.	$17.61
Oats	22,412	103,758	1,728,806 lbs.	912,388	16.7 bus.	8.79
Wheat	22,347	209,315	2,575,996 lbs.	2,697,141	12.3 bus.	12.89
Buckwheat	9,028	33,323	533,670 lbs.	351,171	16.0 bus.	10.54
Rye	2,774	15,679	148,676 lbs.	122,258	9.5 bus.	7.80
Potatoes	81,297	42,621	4,077,066 lbs.	2,278,638	95.7 bus.	53.46
Hay and Forage	61,864	708,900	639,104 Tons	7,492,747	0.90 ton	10.57
Tobacco	9,299	17,928	14,356,400 lbs.	1,923,180	800.8 lbs.	107.27

It will be seen that in total value the potato crop was exceeded by corn, hay and forage, and wheat only, while in the average value per acre it exceeded all of the leading agricultural crops except tobacco. These are significant figures that are worthy of careful thought on the part of our farmers.

It will be noted that the area devoted to the potato crop averaged less than half an acre to the farm, and that the average yield per acre for the state was 95.7 bushels. The following table which shows the acreage planted in 1909, the total yield and the average yield per acre for each county in the state further emphasizes the fact that the crop as grown at present is distinctively one for home or local consumption, the acreage being very generally and comparatively evenly distributed over the state. The same point is graphically shown in Figure 1 in which each dot represents fifty acres planted in potatoes.

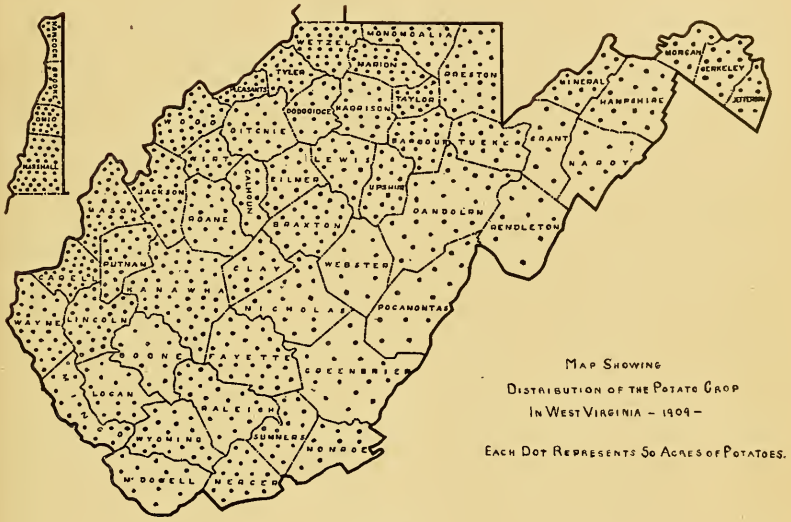

FIGURE 1.

The only counties which ship their product outside of the State to any extent are those lying along the Ohio river. Their surplus goes to the markets of Pittsburg, Pennsylvania and Cincinnati and Columbus, Ohio. Even if every bushel produced was kept at home, we would still have to import from other states enough to feed our own people, as the following figures will show.

TABLE II.—Acreage and Yield of Potatoes by Counties in 1909. (13th Census.)

County.	Acreage.	Bushels.	Average.
Barbour	785	82,005	104.4
Berkeley	452	42,598	94.6
Boone	475	42,515	89.5
Braxton	924	100,820	109.1
Brooke	345	31,014	89.9
Cabell	1,138	84,363	74.1
Calhoun	476	47,862	100.5
Clay	500	43,937	87.8
Doddridge	565	61,173	108.2
Fayette	1,136	113,628	100.
Gilmer	539	55,692	103.3
Grant	312	27,846	89.2
Greenbrier	777	80,125	103.1
Hampshire	728	56,895	78.1
Hancock	272	20,532	75.4
Hardy	341	34,252	100.4
Harrison	772	94,270	122.1
Jackson	1,337	135,083	101.
Jefferson	362	36.551	100.9
Kanawha	2,186	184,453	84.3
Lewis	652	79,067	121.2
Lincoln	1,146	84,482	73.7
Logan	591	46,763	79.1
McDowell	518	34,519	66.6
Marion	997	103,129	103.4
Marshall	1,715	166,590	97.1
Mason	1,520	140,370	92.3
Mercer	699	64,128	91.7
Mineral	536	40,526	75.6
Mingo	605	42,998	71.
Monongalia	654	65,232	99.7
Monroe	393	42,685	108.6
Morgan	294	31,691	107.7
Nicholas	684	77,062	112.6
Ohio	856	75,752	88.5
Pendleton	453	45,517	100.4
Pleasants	504	47,368	93.9
Pocahontas	658	71,486	108.6
Preston	1,193	124,533	104.3
Putnam	940	82,944	88.2
Raleigh	870	84,078	96.6
Randolph	1,211	119,544	98.7
Ritchie	776	93,953	121.
Roane	833	91,625	109.9
Summers	647	67,085	103.6
Taylor	525	54,382	103.5
Tucker	581	66,379	114.2
Tyler	763	77,814	101.9
Upshur	729	70,264	96.5
Wayne	1,268	107,388	84.7
Webster	394	38,699	98.2
Wetzel	1,263	114,569	90.7
Wirt	590	59,109	100.1
Wood	1,349	131,224	97.2
Wyoming	792	58,397	73.7

The United States Census of 1910 gives the annual consumption of potatoes in the northern states as four and a half bushels per capita. These figures do not include the amount required for seed purposes. Assuming that the per capita consumption for West Virginia is but four bushels, it would require in one year 4,884,476 bushels of potatoes to feed our 1,221,119 people. Add to this amount the 500,000 bushels needed to plant the 42,621 acres and we have 5,384,476 bushels as the amount required to supply our needs for one year. Deducting from this amount the yield of 1909 we see that we came 1,307,410 bushels short of supplying our own needs.

Looking at the matter from another point of view; statistics gathered by the Director of the Experiment Station show that during the year between September 30th, 1907 and October 1st, 1908, there were shipped into West Virginia from other states and sold in this state, 1,452,687 bushels of potatoes valued at $1,224,335. Between the same months of 1908-1909 there were shipped into the state 1,822,884 bushels valued at $1,151,709. The following table shows the distribution and value of these potatoes in the latter year in those cities that received 5000 or more bushels and will be helpful as indicating the best markets for home grown potatoes.

TABLE III—*Importation of Potatoes of Several West Virginia Cities.*

Name of Town.	*County.*	*No. of Bus.*	*Value.*
Bluefield	Mercer	45,250	24,200
Buckhannon	Upshur	10,800	5,400
Charleston	Kanawha	492,600	458,860
Clarksburg	Harrison	157,500	95,250
Elkins	Randolph	9,000	6,300
Fairmont	Marion	145,925	129,425
Hinton	Summers	13,000	10,606
Huntington	Cabell	180,030	150,490
Martinsburg	Berkeley	22,550	19,050
Moundsville	Marshall	5,800	4,230
Montgomery	Fayette	27,000	27,000
Morgantown	Monongalia	7,870	5,870
New Martinsville	Wetzel	18,000	12,500
Piedmont	Mineral	16,800	13,440
Richwood	Nicholas	6,000	5,600
Scarbro	Fayette	5,000	4,500
West Union	Doddridge	5,000	4,000
Williamson	Mingo	14,000	14,000
Wheeling	Ohio	88,000	67,760
Welch	McDowell	30,000	24,000

It is apparent then that our farmers have failed to realize as they might, the changed conditions in our markets which have been brought about by the rapid growth of our cities and towns due in

turn to the remarkable industrial development that has taken place in our state during the past decade. There seems to be no valid reason why West Virginia should depend upon the farmers of other states to furnish such a large share of the potatoes consumed by her people, when there are thousands of acres of land within her borders that are splendidly adapted to the growth of this crop.

FIG. 2.—A POTATO FIELD AT LETART, MASON CO.—Typical second bottom land, of which there are thousands of acres, along the Ohio River.

Growing Potatoes for Seed Purposes.

Thousands of dollars are sent out of the state every year for the purchase of seed potatoes. Our growers have considered it necessary in order to maintain their yields to "change" their seed every few years by getting a new supply from one of the Northern states. It has been the opinion that potatoes from Maine, New York, Michigan or Wisconsin were of greater vitality, due to the climate of these sections and the increased yield that has often followed such a change has seemed to afford a good basis for this belief. It is true that the potato is naturally a cool weather plant and thrives best where the summers are rather cool and moist. It is also only natural that the further away from these conditions the plant is grown, the less likely it is to give maximum yields.

Our growers have overlooked the fact that because of the great range in the altitude of the state—from 260 feet to 4860 feet,—we have within our borders counties that have climatic conditions quite similar to New England, Northern New York, Wisconsin and Michigan. Thus in parts of Preston, Pocahontas, Randolph, Tucker,

Webster, Nicholas, Greenbrier, Mercer and Raleigh counties where the altitude is 2000 feet or over the potato finds congenial conditions of soil and climate which should make it as full of vigor and as valuable for seed purposes as those grown in the states mentioned. Our growers should not be obliged to look beyond the boundaries of the state for their seed potatoes. The people of these counties have a splendid opportunity to build up a profitable industry in the growing of seed potatoes to meet this demand.

The amount of potatoes brought into this state for seed purposes is insignificant when compared to the northern grown seed that is used to plant the immense acreage grown in the Eastern Shore of Maryland and Virginia, the Norfolk section of Virginia and in the states to the south of us. Hundreds of thousands of bushels are brought from Maine and Vermont every year to supply the needs of the little peninsular some 70 miles long by 20 wide, the Eastern shore of Virginia. Many of the growers in this section contract with northern growers for their crop in the fall at attractive prices, single contracts calling for as high as 3000 bushels.

It is the belief of this Station that a part of this demand could be, and should logically be filled by West Virginia growers who are located in the higher altitudes of the state, since we are so much nearer this great producing center. In order to test the value of West Virginia seed stock as compared with northern grown seed the following experiment has been tried. In the spring of 1911 this Station furnished a grower in Preston and one in Pocahontas County with enough seed to plant one acre of Irish Cobbler potatoes. As this variety is not grown to any extent in the state as yet, the seed was secured from a large New York potato seedsman. Through the co-operation of the Bureau of Plant Industry of the U. S. Department of Agriculture, a part of the product of the two acres was placed with a large grower near Norfolk, Virginia, and part with the Virginia Truck Experiment Station located at Norfolk. The seed was grown the past season in rows adjacent to others planted with seed from other sources. The following tables show the yields obtained in the above tests.

TABLE IV.—West Virginia Seed Potatoes Versus Northern Seed.

Yields of Primes and Culls from 68 Yard Rows of Irish Cobbler Potatoes from Different Sources, on "Cumberland Farm", Portsmouth, Va.; Frank Lindsay, Proprietor, June 2, 1912.	Rate per Acre.	
	Primes.	Culls.
No. 1.—West Virginia Seed, average yield of 8 rows	70 bbls.	13.3 bbls.
No. 2.—Vermont Seed, average yield of 9 rows	74.3 bbls.	13.1 bbls.
No. 3—Louisville, Ky, 2nd crop, average yield of 8 rows	63.4 bbls.	6.2 bbls.
No. 4.—Maine Seed, average yield of 6 rows	83.0 bbls.	8.9 bbls.
No. 5.—West Virginia Seed, average yield of 15 rows	81.9 bbls.	14.8 bbls.
No. 6.—Virginia Home-grown Seed, average yield of 8 rows	44.4 bbls.	10.0 bbls.

Yield of Primes and Culls of Irish Cobbler Potatoes Grown at the Virginia Truck Experiment Station, Norfolk, Va., from Seed from Different Sources, July 16, 1912.	Primes	Culls	Rate per Acre.	
			Primes	Culls
	Lbs.	Lbs.	Bus.	Bus.
West Virginia Seed, yield from 31–8 rod rows	1943	262	115.0	15.5
Maine Seed, yield from 20–8 rod rows	986	160	96.9	14.6

It will be seen that the results of the past season's test are very favorable to West Virginia seed.

If our growers are to attempt to capture a part of the seed trade of this section, they will have to grow the variety planted almost

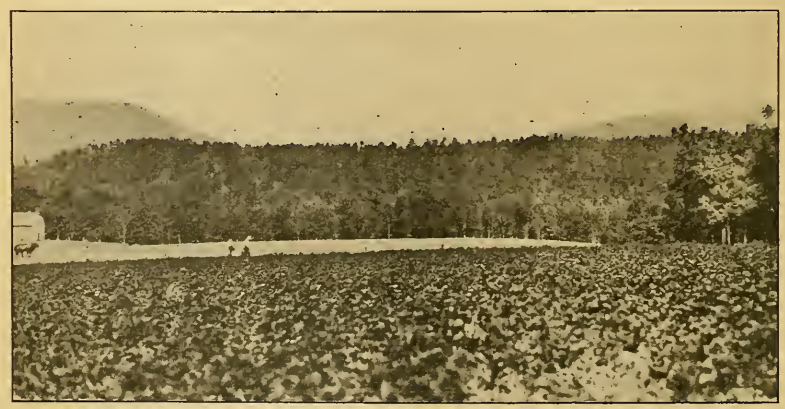

FIG. 3.—Potatoes thrive on the many large, smooth, level fields that are found among our hills.

exclusively there, i. e. the Irish Cobbler. Indications are that this variety will not yield as heavily as some of the later varieties, but

in net profit the increased price obtained should more than make up for the difference in yield. To become a factor in the seed potato business it will be necessary for communities that are favorably located as to soil, climate and shipping facilities to produce them in such quantities as will allow of shipment in car load lots. There are many such communities in the counties mentioned. Figure 3 shows part of a field on the farm of Mr. J. J. Coyner, Clover Lick, a successful grower whose crops average 200 bushel or over per acre.

The Potato Crop Fits in Well With Present Farm Practices.

In urging the increased planting of the potato as a truck crop the writer is advocating no radical departure from present farm practice. No system of farming can be considered a proper system at the present time which does not seek to maintain the fertility of the land by a wise rotation of crops and the use of leguminous plants. The potato crop is very easily made a part of such a system, and in addition to being a profitable money crop the clean cultivation and liberal fertilization which are essential to the best success with this crop leave the land in good condition for the following crop.

The growing of two acres of potatoes per farm or four times the present average acreage would entail practically no additional outlay for equipment, except a plow-digger and a sprayer, the combined cost of which should not exceed $40.00. An equipment of planter, riding cultivator, four row power sprayer and elevator digger can be bought for $275.00 or less. It should be possible for several growers in a neighborhood to combine forces and thus reduce the individual expense. With such an outfit the grower can handle five acres as easily as he can two acres with the ordinary equipment.

The Experiment Station desires to co-operate with all who are interested in growing potatoes, particularly those who wish to enlarge their acreage, and to that end invites correspondence on the subject.

Essentials of Culture.

It is impossible, within the limits of this bulletin to any more than briefly outline the most essential factors in the culture of the potato as a truck crop. These are treated topically in the sequence in which they naturally come from seed time to harvest.

Place of Crop in Rotation. Wherever possible the potato crop should follow one of clover. In cases where it is difficult to get a stand of clover, cow peas, soy beans or oats and Canada field peas may be substituted. These are all leguminous crops (excepting the oats) and make fine feed for stock. The best crop with which to follow the potato crop will depend upon the location of the farm, the system of farming pursued and the fertility of the land. The following are merely suggestive. A very common rotation is potatoes, wheat in which is sown timothy in the fall and clover in the spring, clover and timothy and back to potatoes again. In some cases the farmer may wish to keep his field in grass two years, in which case the rotation would be a four year one and the potatoes would follow the timothy. In the higher altitudes of the state oats would in many cases take the place of the wheat. For such locations, potatoes with a cover crop of rye that would furnish good early pasturage may be followed by buckwheat in which clover is sown to make the crop the third year. Another rotation which some may prefer would be potatoes with cover crop of rye, corn, wheat or oats, clover. If the land is at all inclined to be poor a three year rotation in which clover is one of the crops will by all means be the best one to follow.

Soil. The potato can be grown upon any type of soil in the state but gives best results on the sandy or clay loams which contain plenty of humus. The lighter soils are best adapted to the early crop. Clayey soils should be well drained and are improved by liberal applications of barnyard manure.

Preparation of the Soil. With the heavier types of soil or if the crop is to follow sod, the land should be plowed deeply in the fall or winter, in order to expose the soil to the mellowing action of the frosts or to effect the decay of the sod that is plowed under. Spring preparation should begin as early as the ground is fit to work. On some soils that are fall plowed it will only be necessary to harrow them well in order to fit them for planting, but in cases

where the soil has been compacted by heavy rains during the winter, they should be plowed again in the spring, though not as deeply as in the fall. Harrowing should follow directly after the plowing, and should be repeated if some days elapse before the crop is planted, to conserve the moisture that has been stored up in the soil during the winter and to kill weeds that may have started. The seed bed should be made mellow to a depth of from four to six inches and left level. A cutaway or a disc harrow are splendid tools with which to follow the plow and pulverize the soil. The Acme harrow levels the soil and puts it in good shape to receive the seed. In order to obtain maximum yields, preparation of the soil should be more thorough than is usually practiced.

Fertilizers. The fertility of a soil is so affected by varying conditions of location, formation and previous treatment, that the problem of what kind of fertilizer and how much to use is necessarily one that must be worked out by the individual farmer. Before investing heavily in commercial fertilizers he should make sure that he has done everything that he can do to enable the plant to appropriate what it needs from the vast store of fertility already in the soil. Good drainage, thorough tillage, liming, proper rotation of crops and the maintenance of a liberal supply of humus in the soil are all factors which greatly increase the yield of any crop, and it requires good judgment and labor rather than the expenditure of much money to bring about these favorable conditions.

It is probable that barnyard manure forms the bulk of the fertilizing material applied to the potato crop in this state; and in a general way it may be said that there is nothing better than a liberal supply of this material. An application of from twenty to thirty loads per acre is sure to produce beneficial results. Its value lies not alone in the elements of fertility which it adds to the soil; it adds humus, increases the water holding capacity of the soil, makes it more friable and creates favorable conditions for the work of useful bacterial life in the soil.

Barnyard manure should be well decayed if applied to the potato crop in the spring, since the use of fresh barnyard manure favors the development of scab on the potatoes. Fresh manure is better plowed under in the fall, or applied liberally to the crop that precedes the potato crop.

The writer recommends that our farmers take better care of the manure made on the farm; that they use it as liberally as possible

on their potato land; that so far as possible the potato crop shall follow one of clover, cowpeas, or a cover crop of crimson clover, vetch or rye, and that they experiment upon their own farms to find out the kind and amount of fertilizer that will give the best results. In the large potato growing sections of the country it has been found profitable to use liberal amounts of commerical fertilizers, in many instances as high as a ton to the acre, and there is no doubt but that a judicious use of this material would increase the profit to be derived from the crop in this state.

Most soils in West Wirginia are most deficient in phosphorus and probably next to phosphorus, nitrogen is the element most needed. A fertilizer analyzing 3% nitrogen, 10% phosphoric acid and 6% potash, applied at the rate of 1000 to 1500 pounds per acre, is suggested as a good formula to serve as a basis for further trial. Best results will be obtained by applying about one half of the fertilizer in the furrow and half broadcast.

Varieties. Varieties of potatoes show wide differences in their productivity and the grower is primarily interested in securing the variety that will turn out the largest number of bushels of marketable tubers to the acre. There are certain demands of his market however, to which the variety must conform in order to bring the best prices and these should be given careful study. Most markets prefer smooth, white-skinned potatoes of uniform size and shape. Those of medium size (say 8 to 12 ounces) are preferred to larger ones.

The problem of choosing a variety is complicated by the long list offered by seedsmen (one New York firm cataloguing 70 varieties. In many cases there is not enough difference between two or more of such varieties to justify different names. Every effort should be made by all who are interested in the potato crop to keep the number of trade names down to a minimum so that they will stand for definite varietal characteristics.

During the last eight years this Station has tested for one or more years over 100 different varieties of potatoes. Notes on these varieties together with the records of their yields will soon be published. It will be of interest to note here the varieties that have given the largest average yields of marketable potatoes during seven years's testing. They follow in the order of their yield. 1. Great Divide. 2. State of Maine. 3. Early Harvest. 4. Lawrence Seedling No. 1. 5. Houlton Early Rose. 6. Burpee's Su-

perior. 7. Early Puritan. Of these varieties, the first, second, fourth and sixth are suitable for the main crop planting while the third, fifth and seventh are medium early in season. The above named varieties are illustrated in figure 4.

In a four year's test reported in Bulletin 98 of the Pennsylvania Experiment Station the varieties that gave the highest average yields during the test follow in the order of yield in each group. *Early*: Six Weeks, Irish Daisy. *Medium late (or medium early)*: Early Puritan, Early Rose. *Late*: Heath's Medium Late Surprise, Whiton's White Mammoth, Vermont Gold Coin.

Other varieties that are well known in the large markets are: Irish Cobbler and Bliss' Triumph among the early and Carman No. 3, Rural New Yorker, Green Mountain and Peerless among the late sorts.

As far as possible the grower should plant the varieties that have proved most profitable in his neighborhood and on his type of soil. As is brought out on page 268 it is better to grow but few varieties in the same section.

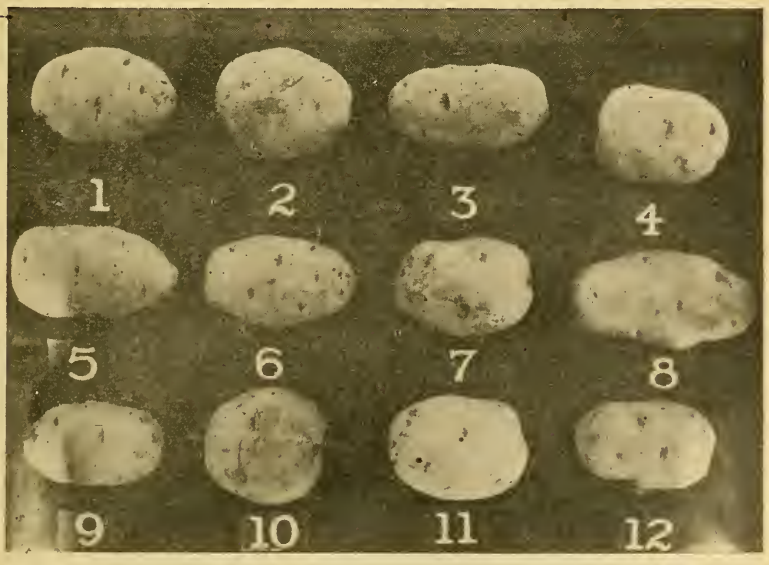

FIG. 4.—TYPICAL SHAPED TUBERS OF SOME GOOD VARIETIES.—1, Early Harvest; 2, Irish Cobbler; 3, Great Divide; 4, Irish Daisy; 5, State of Maine; 6, Houlton Early Rose; 7, Lawrence Seedling No. 1; 8, Burpee's Superior; 9, Early Puritan; 10, Triumph; 11, Carman No. 3; 12, Gold Coin.

Source of the Seed. The custom of sending to some of the northern states for new seed every few years is no doubt justifiable *under the present methods of seed selection and care,* because of the increased yield which so often follows such a change. In buying new seed however, there is the danger of introducing disease or of securing an inferior variety in place of the one ordered. With the development of the seed potato industry as already suggested, and with proper methods of seed selection and care of the seed stock until planting time, there should be no need of sending outside of our own state for seed stock.

Seed potatoes should be firm, smooth, true to the variety type and free from disease. Great care should be taken to keep the seed from sprouting in the dark for the sprouts will either have to be removed or will be broken in the process of planting. Their growth reduces the vitality of the seed and causes a reduced yield. If it is impossible to prevent the potatoes from sprouting they should be allowed to sprout in the light, in which case short, strong, dark-green sprouts will form. These will not be broken in planting and do not waste the vitality of the seed. This method is sometimes used on a small scale to secure unusually early potatoes.

Cutting the Seed. The concensus of opinion seems to be that best results following the planting of seed that has been cut but a short time. If, because of pressure of time, it seems advisable to cut the seed several days before planting, the pieces should be dusted with air slaked lime or land plaster. Care should be taken to prevent either the drying out or the heating of the seed pieces.

Size of the Seed Piece. The use of small potatoes (weighing less than 2 oz.) for seed purposes is to be condemned as a general practice as having a decided tendency to cause deterioration in the variety. The best practice seems to be to use medium sized tubers and cut to pieces weighing from one to two ounces. In most cases the pieces will have two eyes. The amount of seed required to plant an acre in this way will vary from twelve to fifteen bushels.

Planting the Crop. The bulk of the potato crop in West Virginia at the present time is planted by hand. Where it is grown as a truck crop, however, with five or more acres in a field, it will pay to use a planting machine. There are two types of such a machine upon the market. They both open the furrow, deposit the fertilizer in the furrow (if provided with fertilizer attachment) mix and cover the same, drop the seed, cover it and mark the next row as

they go. They are easily handled by two horses and growers owning either kind think that theirs is the best machine on the market—

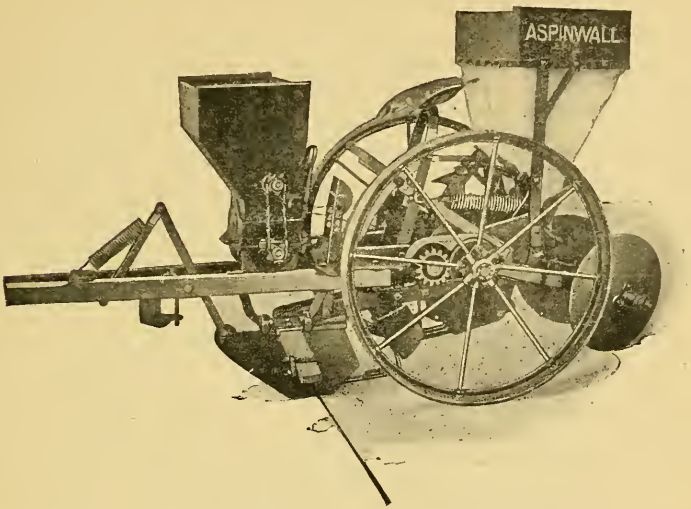

FIG. 5.—The "Picker" type of potato planter with fertilizer attachment.—*Courtesy Aspinwall Mfg. Co., Jackson, Mich.*

in other words both do good work. In one type as shown in figure 5, the pieces are automatically fed within reach of metal fingers or "pickers" which carry the seed piece and drop it into the ground. In the other type of machine, as shown on the front cover page, the pieces are automatically fed on to a revolving table that is divided into sections. A man or boy sits on behind and sees that each section carries but one piece over the tube through which it drops to its place in the furrow. In each machine the depth of planting and the distance between hills can be readily adjusted so as to secure more uniform work than can be done by hand.

DISTANCE OF PLANTING. The distance between rows and between the hills in the row should be varied to suit the habit of growth and the season of maturity of the variety. Early maturing varieties of upright habit may be planted as close as 27x12 inches. If of spreading habit, 30 x 12 inches would be better. For late maturing varieties, most of which should finally cover the space between the rows, the distance may vary from 30 to 33 inches by 14 to 18 inches.

If a home-made spraying outfit is to be used care should be taken to see that the rows are so placed as to allow the wheels of the

sprayer to run in the centers between each two rows. Power sprayers are made with wheels adjustable to different widths of rows.

Depth of Planting. The depth of planting should be governed by the kind of cultivation to be given, whether level culture or a modified ridge culture. For average soils and seasons, level culture seems to give best results. With this system, the potatoes are planted about four inches below the surface of the ground and in cultivating the crop the ground is kept as nearly level as possible. On heavy soils three inches and a modified ridge culture will be better, as is the case too if the potatoes are to be dug with a potato digging

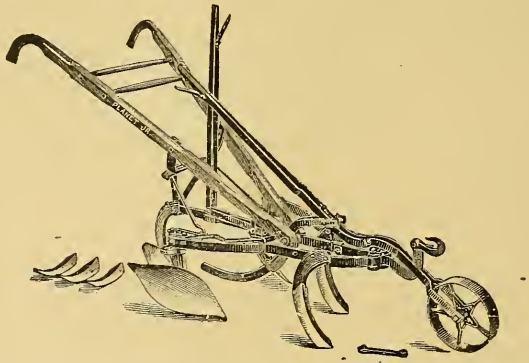

Fig. 6.—A good type of cultivator—*Courtesy S. L. Allen and Co., Philadelphia, Pa.*

machine. In the latter system of culture the first cultivations are the same as in the level culture system, while at the later cultivations, winged teeth replace the two rear straight ones on the cultivator (see figure 6). and a small amount of soil is thrown towards the rows. This practice helps also in smothering out small weeds, which, starting in the middle of the potato rows would prove troublesome later on. The practice of planting potatoes shallow and then throwing a decided ridge over the rows should be discouraged.

Time of Planting. The best time to plant potatoes in West Virginia will vary greatly, depending upon the locality in the state with respect to both latitude and altitude, also with the season at which the crop can be marketed to the best advantage, and with the place the crop occupies in the crop rotation. It is a point that should be given careful study by our growers, and one that will be the subject of further investigation by this Station.

In a general way it may be said that for points in the Ohio and

Kanawha river valleys and for other parts of the state where the elevation is below 1000 feet, an effort should be made to grow an early maturing variety, such as Irish Cobbler which could be marketed from the first to the middle of July. Crops marketed at this time should compete on favorable terms with the crop of the Norfolk, Virginia section. They would also avoid the extreme heat of the summer which is apt to prove disastrous to later planted or later maturing varieties in such sections.

For points in the Ohio valley north of Parkersburg and in sections of the State having an elevation of over 1000 feet, it is probable that the medium or late maturing varieties which can be harvested from the middle of July to the middle of September would prove most profitable, as they would come on the market between the crop of the Norfolk, Virginia section and that of the Northern states.

It will help to determine the best date of planting if one has in mind the fact that the early varieties may mature in from 70 to 90 days from planting, the medium earlies (or medium lates) from 90 to 130 days, and the late varieties may require 200 days in which to reach maturity. Early potatoes may fit into some crop rotations better than late potatoes and vice versa.

Cultivating the Crop. About a week after the potatoes have been planted the field should be gone over in both directions with a spike-tooth harrow or weeder. This will kill any small weeds that have started, level the ridges left over the furrows and conserve the moisture by breaking the crust that will have formed. This should be repeated in another week, and can be continued until the plants have reached a considerable size, if the harrow teeth are adjusted to slant backwards.

As soon as the rows are clearly defined, cultivation should be started between the rows. For this purpose either a one-horse, five-toothed, walking cultivator (as shown in figure 6) or a two-horse riding cultivator (as shown in figure 7) will be found much more efficient than either a single or double shovel plow, such as is in common use. They can be readily adjusted to work at varying depths and widths. The rear tooth, as shown on the tool in figure 6 is used only in the later cultivations (see under depth of planting). For the earlier cultivations the small teeth shown in the rear of the cut are used. The first cultivations should loosen the soil as deeply as possible, and as near to the rows as can be done without

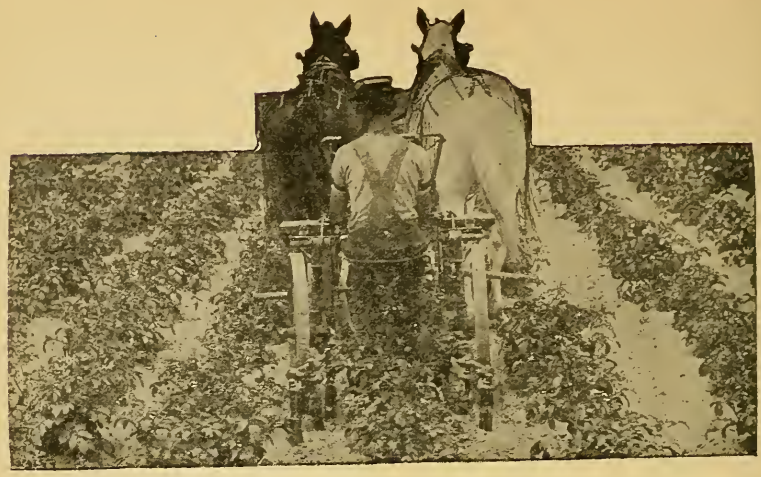

FIG. 7.—A riding cultivator—*Courtesy Bateman Mfg. Co., Grenloch, N. J.*

injury to the roots of the plant. As the plants increase in size cultivation should become more shallow and be confined more to the middles between the rows. The number of cultivations necessary will be governed somewhat by the season. It should be kept up until the vines interfere. As suggested before, it is well during the later cultivations to throw some soil toward the plants in the row in order to smother the weeds that would otherwise become troublesome. The value of thorough and frequent cultivation was conclusively shown in some experiments carried on at the Experiment Station at Cornell University* in 1895-8. On land which received no fertilizer they were able to maintain a yield of over 300 bushels per acre. From seven to nine cultivations gave better results than a greater or less number.

INSECTS AND FUNGOUS DISEASES. There are several insects and fungous diseases which are apt to cause serious injury to the potato crop and every grower should be able to recognize these and apply the remedy. A description of the ones most commonly found in this state will be followed by an outline of treatment for their control.

The Colorado potato beetle is perhaps the most injurious insect affecting the potato crop. It is too well known to need description. The beetles appear when the plants are quite small and lay their eggs in clusters on the under surface of the leaves. The beetles

*Cornell University Bulletin 228, page 444.

sometimes cause considerable damage by eating the young foliage, but the greatest harm is done by the larve which hatch from the eggs in about a week. They feed voraciously on the foliage, stripping the plants in a short time, if not checked. They are much easier to kill when small and if the first brood is killed, there will be little trouble from the feeding of the second brood, which would otherwise be present later in the season.

The "old fashioned potato bugs" which are different species of "blister beetles" are sometimes plentiful enough during mid-summer to do considerable damage to the foliage of the potato. This is a case where of "two evils one should choose the lesser", for the larval form of these insects devours the eggs of grass hoppers and in this way might be classed as a beneficial insect. Fortunately they are not often numerous enough to do much damage.

Flea beetles are almost, if not quite, as serious an enemy of the potato as the potato beetles even though their work is not quite as conspicuous. These lively little black insects(about one sixteenth of an inch long) seem to be ready for the potato plant as soon as it is out of the ground and get to work at once puncturing the leaves so that they look as though they had received a dose of bird shot. Working as they do when the plant is so young the numerous holes which they make cannot help but seriously weaken the plant by causing excessive evaporation of moisture. The holes also favor tip-burn and sun scald and make it much easier for the blights to gain an entrance to the tissue of the plant, as the insects continue their work throughout the season.

In every day language it has become customary to term any disease or injury to the potato plant, resulting in its withering, decay or cessation of growth, whether due to the attacks of insects, fungous diseases or unfavorable climatic conditions as the "blight."

In the light of modern knowledge of potato troubles, this term should have a more definite meaning, and be restricted to the two fungous diseases, early-blight (Alternaria solani) and late-blight (Phytophthora infestans) which are due to specific organisms. There are two physiological troubles which produce a general effect upon the plant quite similar to these two diseases and which are often confused with them, namely "Sun scald" and "Tip-burn". It is necessary to keep the distinction in mind because it is possible to control the true blights by spraying, while to remedy tip-burn and sun scald other measures must be employed.

"Sun scald occurs when bright hot weather follows suddenly upon a moist, cloudy period. The scalded areas occur especially between the veins and near the extremities of the leaflets. It is commonest during the period of most rapid foliage development, i. e., before blossoming." *

"The name tip-burn is well applied to the drying and death of the leaves beginning at the tip and margin as a result of protracted, dry heat. The dead areas blacken, crisp and uproll. Insects and other injuries aggravate the trouble. It is commonest after the plants have passed their greatest vigor, i. e., after blossoming." *

It is probable that one year with another these two troubles cause more damage to the potato crop in West Virginia than early and late blight put together. Having their origin in climatic conditions and being concerned chiefly with the moisture supply any means that may be taken to conserve this, should be employed. Frequent, shallow cultivation during a dry period and the maintenance of a liberal supply of humus in the soil at all times are the best known safeguards against the occurence of these troubles. Spraying with Bordeaux mixture also helps to reduce the injury.

"The early-blight appears as small, irregular, sharply defined black spots on the leaves, marked by faint, target-board-like, concentric ridges. These begin to show earlier than the late-blight and in dry weather, indeed, it is rather characteristic of dry, warm soils. The progress of the disease is slow, but as the spots increase in number and size they may ultimately destroy the entire foliage, either alone or in combination with tip-burn and other maladies."*

The late-blight is a far greater menace to the potato industry than the early-blight. The loss in the 1903 crop in New York State alone was estimated as 20,000,000 bus. It is most prevalent in the northern states and generally causes its greatest damage late in the season by causing a rot of the tubers, as well as a premature destruction of the vines. Outside of these states its appearance is sporadic. The past season is the only one in the last four years that the writer has found any serious damage from this disease in West Virginia, and this year it was found only in the higher altitudes of the state. Under favorable weather conditions (moist and rather cool) the disease appears as purplish-black or brownish-black areas on the potato leaves, usually on the lower ones first.

*U. S. Dept. of Agr. Bureau of Plant Industry, Bulletin 254.

*Loc. Cit.

The casual observer is not apt to notice the disease until the upper leaves are attacked and blackened by infection which has taken place from the lower leaves some days or even weeks before. The spread of the disease depends upon the weather: if dry, the infested spots curl up and shrivel; if moist, the blighted leaves become limp and soon rot. It is quite possible for the foliage of the entire field to be killed within a week from the time the disease is first noticed.

When the late-blight destroys the foliage of a field the tubers usually show the rot which is caused by the same organism that caused the death of the leaves. It may be a wet or a dry rot, depending upon the amount of moisture in the soil. A characteristic rank odor is given off both by the diseased tops and the tubers affected with the "wet-rot." The "dry-rot" shows as a brownish or purplish discoloration of the skin which becomes sunken in the parts affected. The "dry-rot" may develop to a considerable extent during storage but if the tubers are kept in a cool, dry cellar this form of the rot may be checked. It is best to delay digging potatoes in fields in which the blight has killed the tops, until a week or more after they are dead.

Whenever an irregular stand or weak plants are noticed investigation may show this condition to be due to a bacterial disease called "black-leg". It is carried on the seed potatoes and as it is quite common in the northeastern states it has no doubt been introduced to some extent into this state. It causes the seed pieces to rot early in the life of the plant. This checks the growth of the top, and the leaves, beginning with the lower ones, gradually become paler, roll upward and finally die.

A disease which from its similar effect upon the plant may be easily confused with the black-leg disease is the Fusarium blight and dry rot of the potato. This disease has caused much damage in Ohio and other states and has been reported in this state. It is of fungous rather than of bacterial origin. "The best marked symptoms are the falling or lopping over of the stems and the wilting or curling of the foliage as a result of the killing of the smaller roots by this fungus. The tubers are later invaded and develop especially in storage, a blackening of the vascular ring near the stem end. The further development of the fungus in the storage bin may lead to dry-rot, especially at the stem end of the tubers, and in

advanced stages the fungus may appear as white tufts of mold on the surface".*

A quite common disease affecting the tubers is that known as potato scab. It is caused by a fungus which produces a roughened or pitted appearance on the surface of the potato and injures the market value to a considerable extent. It thrives best in alkaline soil and for this reason fresh stable manure, lime, or wood ashes should not be applied directly to the potato crop.

Plant Clean Seed. The potato grower should make every effort to keep disease from getting into his fields. As such diseases as scab, black-leg, late-blight and Fusarium wilt are carried on the seed, care should be taken that only healthy seed is planted. Tubers showing a discoloration of the skin or flesh should be rejected if badly affected. If but a part of the tuber is affected, that part at least should be cut out and destroyed.

Disinfecting Seed. As a precautionary measure, when new seed is introduced or old seed becomes affected, it should be disinfected by soaking the uncut seed for two hours just before planting, in a solution made by adding one pint of formaldehyde to 30 gallons of water. The solution can be used repeatedly without losing its efficiency. After soaking the required length of time, the tubers should be removed and allowed to dry before planting.

A rotation of crops in which the potato occupies the ground not oftener than once every three years should be adopted as affording one means of controlling the diseases that persist in the soil.

Spraying. Fortunately it is possible to combine the treatment for many of the insects and diseases, and by thorough spraying to control them in large measure. The materials most effective are Bordeaux mixture which controls the early and late-blight, and Paris green, or arsenate of lead which controls the Colorado potato beetle and the blister beetles. The combination of Bordeaux mixture with one of the above named insecticides acts as a repellent and protects the plants from injury by the flea beetles. Bordeaux mixture as used in potato spraying is a solution of 4-6 pounds of copper sulphate (blue-stone or blue vitriol) and 4-6 pounds of lime in 50 gallons of water. To make the mixture conveniently, four fifty gallon barrels are needed. Whisky, vinegar, oil or gasolene barrels are usually obtainable for this purpose. A mixing station as illustrated in figure 8 is a great help. It should be con-

*Loc. Cit.

structed where it will be as handy as possible to both the field and water supply. In the top of one of the barrels 50 pounds of copper sulphate is suspended in a burlap sack and the barrel filled with water. It will dissolve in a few hours. In another barrel 50 pounds

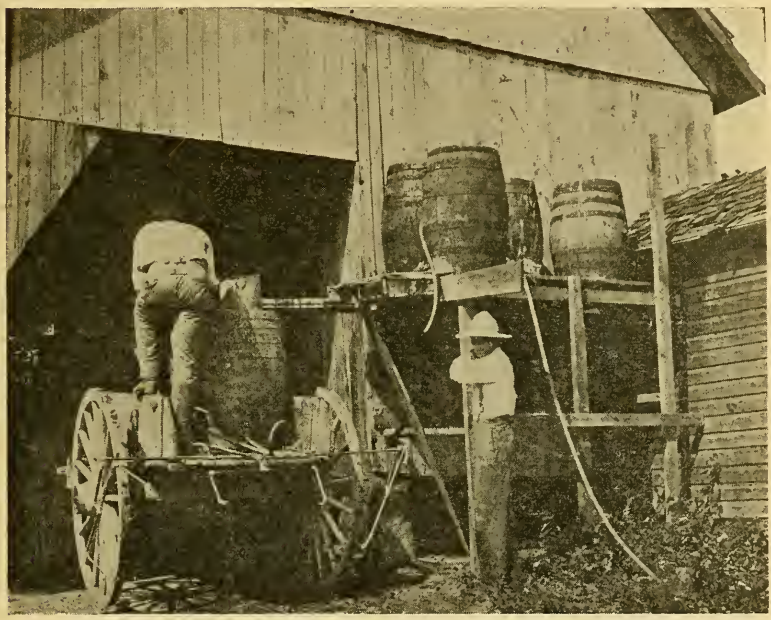

Fig. 8.—A Mixing Station is a Great Help in Spraying.

of fresh burnt lime is slaked and the barrel filled with water. These two barrels are called the "stock solution barrels". For the first two sprayings four pounds of copper sulphate and four pounds of lime to each 50 gallons of water is sufficient. If the spray tank holds 50 gallons of material it would be filled as follows. Dip four gallons (containing 4 lbs.) of copper sulphate from the copper sulphate stock solution and dilute with water in the third barrel to 25 gallons. Dip four gallons, (containing 4 pounds of lime) from the lime stock-solution (after stirring well) and dilute with water in the fourth barrel to 25 gallons. The last two barrels should be equipped with stop-cocks which allow the contents of the barrels to be drawn off at the same rate onto a screen (to strain out coarse particles of lime) and thence by gravity into the spray tank below. If the spray tank holds 100 gallons, of course the amount of copper

sulphate, lime and water would be doubled. For the third and later sprayings, six pounds of copper sulphate and six pounds of lime should be used to each 50 gallons of water. Paris green when combined with Bordeaux mixture should be used at the rate of one pound to 50 gallons of the mixture. When used in water at this rate two gallons of milk of lime should be added in order to prevent burning of the foliage. Arsenate of lead is used at the rate of 3 pounds to 50 gallons of Bordeaux mixture or water. It does not burn the foliage, stays in suspension better and adheres to the foliage better than Paris green and for these reasons is replacing the latter to a considerable extent.

Spraying should begin when the vines are about six inches high and should continue at intervals of ten days to two weeks until from four to six sprayings have been given. To be effective the spraying must be thoroughly done. The material should be kept agitated and delivered in a fine mist so that every portion of the

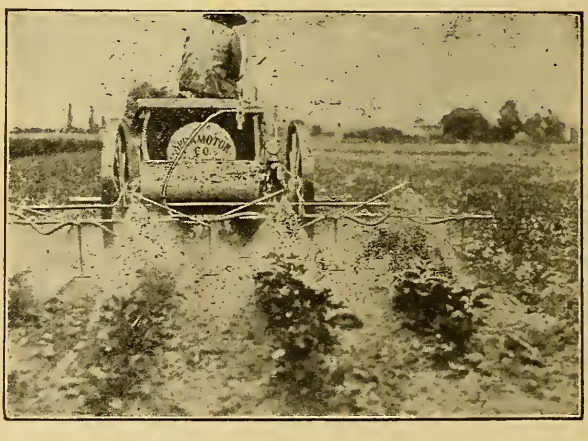

FIG. 9.—A FOUR-ROW POWER POTATO SPRAYER, WITH EXCELLENT ARRANGEMENT OF NOZZLES.—*Courtesy of the Spramotor Co., Buffalo, N. Y.*

foliage will be covered. To do this well will require 100 gallons of spray material to the acre for all sprayings after the second one. It is better to go over the field twice at a spraying, or to make more frequent sprayings than to try to use a coarse spray and put that amount on in one spraying.

There are several makes of potato sprayers upon the market that obtain power from the wheels and spray from four to six rows at

a time. One such is shown in figure 9. The chief fault with many of these sprayers as equipped by the factories, is that they do not distribute the spray as thoroughly as they ought to for best results. A grower with more than two acres will find such a machine almost indispensible, however. A hand spray pump of some kind is fast becoming a necessity on every farm. It is quite possible to connect whatever pump may be available to a system of piping so that it may be used for spraying fields up to two acres or so in extent. The pump in figure 10 is one that the owner bought equipped with hose and nozzels for spraying his orchard. The wheels and tongue

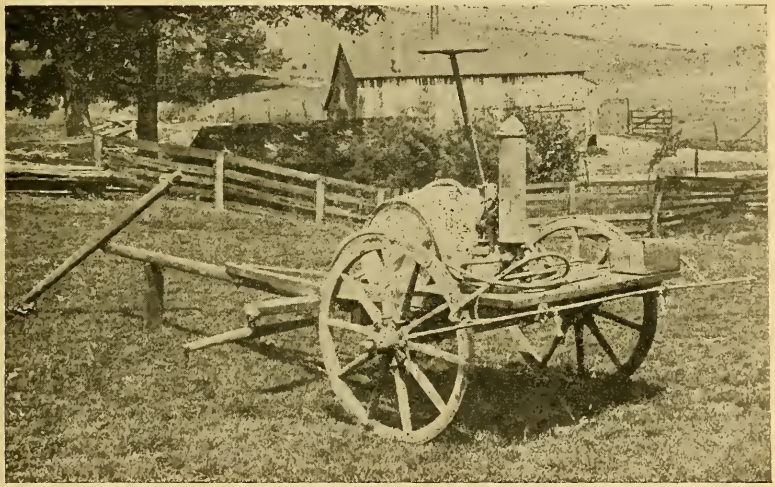

Fig. 10.—An Orchard Spray Pump, Changed to a Potato Sprayer.

were taken from a worn out threshing machine, the only money outlay in adapting the spray to field work being $1.43 spent for the pipe fittings which were obtained from the local plumber. Figure 11 illustrates another home-made sprayer, attached to an ordinary farm wagon, which will distribute the material more effectively than that shown in figure 10. A two-wheeled vehicle is much to be preferred wherever possible, as it is much easier to turn at the ends of the rows and does not pack the soil or injure the vines as much as a four wheeled one. Figure 9 illustrates perhaps an ideal arrangement of pipes. These can be obtained of the manufacturer in such a form that they can be attached to the bed of any farm wagon.

Spraying experiments with potatoes have been carried on annu-

ally at the Vermont Experiment Station for 20 years, during which period the average increase due to the spraying has been 105 bushels per acre. *

During a ten-year experiment at the New York Experiment Station at Geneva, the average increase in yield from three sprayings has been 69 bushels per acre, and from five to seven sprayings,

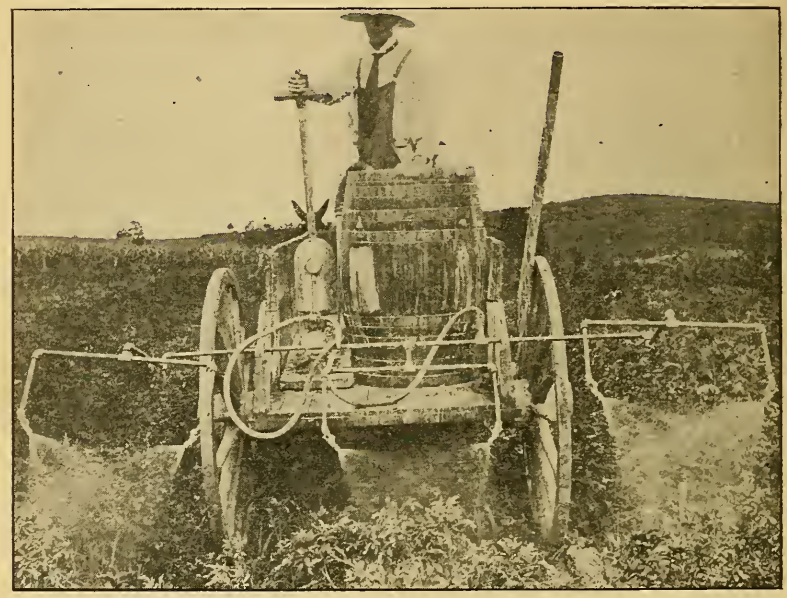

FIG. 11.—AN EXCELLENT HOME-MADE ARRANGEMENT OF PIPES FOR SPRAYING POTATOES.

97.5 bushels per acre. In some farmers' business experiments, six to fifteen of which have been carried on in New York each year for nine years, the average total expense of spraying per acre has been $4.74 and the average *net* profit from spraying $14.43 per acre. †

HARVESTING THE CROP. The time of harvesting the crop will vary with the size of the potatoes and market conditions. In the southern portion of the state at low elevations it will doubtless pay to dig at least a portion of the crop before it is fully mature, in which case it will be best to follow the method practiced in the Norfolk, Virginia, potato section. Here almost the entire crop is dug with a light turning plow. Wherever the crop is left in the

*U. S. Dept. of Agr. Bureau of Plant Industry, Bulletin 254.
†New York Experiment Station, Geneva, Bulletin 349.

ground until mature and the land has been kept reasonably free from weeds, one of the elevator types of diggers shown in figure

FIG. 12.—AN ELEVATOR DIGGER IS NECESSARY ON LARGE ACREAGE.

12, is the most satisfactory means of getting the potatoes out of the ground, and will be found almost necessary in fields of five acres or more in this state. These diggers lift the potatoes, shake them free from the soil on the elevator and drop them on top of the ground as shown in figure 13 in such shape that they can be quickly picked up. For smaller fields one of the simpler and less expensive types of diggers is fairly satisfactory. These are made somewhat like a double-mould-board plow with several prongs extending outward and backward, which separate the potatoes from the soil.

SEED SELECTION. The proper selection of their potato seed at digging time and the careful storing of the same during the winter is one of the means of maintaining or increasing their yields, which practically all of our farmers have failed to make use of. The almost universal practice among our farmers has been to sell the best of their potatoes in the fall and put into the cellar what they think will be enough for their own use and to plant the next year's crop. During the winter or early spring they may select and put to one side some of the best of these for seed, but in many cases they are no better than good seconds. This practice is open to serious objections. Any one who has dug potatoes by hand cannot

FIG. 13.—POTATOES AS LEFT BY THE ELEVATOR DIGGER.

have failed to be impressed with the great variation in the yield of the individual hills. Some may contain a goodly number of large, uniform tubers, others a few large tubers and several small ones, others may contain many small potatoes, and others but one or two good sized ones. To illustrate this point, attention is called to figures 14, 15 and 16.

185 tubers 47 lbs. 9 oz. 97 tubers 6 lbs. 4 oz.

FIG 14.—Product of 34 high yielding hills. Total weight 53 lbs. 12 oz.

Figure 14 shows the product of 34 high yielding hills in which there were 185 merchantable potatoes (in the large pile) weighing 47 lbs, 9 oz. and 97 culls (in small pile) weighing 6 lbs. and 4 oz.

215 tubers 39 lbs. 10 oz. 269 tubers 15 lbs. 14 oz.

FIG. 15.—Product of 106 low yielding hills. Total weight 55 lbs. 8 oz.

Figure 15 shows very nearly the same total yield, the product of 106 low yielding hills in which there were 215 merchantable potatoes (in the large pile) weighing 39 lbs. 10 oz., and 269 culls (in small pile) weighing 15 lbs. and 14 oz. Both lots of potatoes were selected by the writer from three adjacent rows of Early Rose potatoes grown at the Experiment Station at Morgantown the past season. They were dug by hand and each hill kept separate. It will be seen that the average yield of merchantable potatoes in the high yielding hills was 22.38 ounces per hill, while in the low yielding hills the average yield of merchantable potatoes was 5.88 ounces per hill. Assuming that the potatoes were planted 15 inches apart in rows 3 feet apart, with a 90% stand there would have been 10455 hills to the acre. If all of the hills had come up to the average of the high yielding hills the acre would have produced 243.7 bushels of merchantable potatoes. If all of the hills had produced at the same rate as the low yielding hills, the yield per acre, with a like stand, would have been 64 bushels per acre. The actual yield of the field was at the rate of 161.2 bushels of number one potatoes.

Figure 16 represents the product of two hills of Carman potatoes taken from the same field as the Early Rose. The hill at the right contained 14 potatoes weighing 58½ ounces, the one at the left 6 potatoes weighing 24½ ounces. On a basis of 10455 hills to the acre, the yield of the former would be at the rate of 637 bushels per acre, while that of the latter would be 266 bushels per acre, a difference of 371 bushels per acre. The 24½ ounce hill was somewhat better in weight than the average hill and much better in quality for all of its tubers were of merchantable size.

After the farmer has mixed his potatoes in the bin he has no way of telling whether the tubers he selects for planting came from

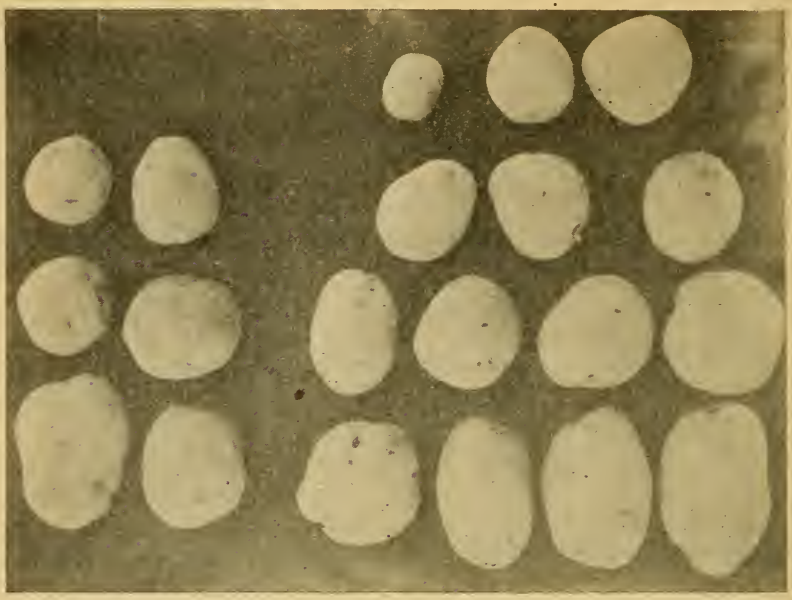

FIG. 16.

An average hill of Carman No. 3, 24 1-2 oz.

A high yielding hill of Carman No. 3, 58 1-2 oz.

high or from low yielding hills. The chances are that he unconsciously plants many potatoes that were the product of low yielding hills and these cannot help but reduce the possible yield of his crop. On the other hand by carefully selecting at digging time only the high yielding hills he knows the quality of his seed and will be able to increase his yield, the increase coming from the larger percentage of hills that will be of high productive power.

The following practice of seed selection is suggested as easily carried out on any farm and one which will tend to increase the potato yield of the state. Next fall dig several rows by hand in the best part of the field, placing each hill by itself. When all are dug go over the hills and pick up all those that are clearly inferior. From those that remain select enough of the best to plant a multiplication plot the following year. To determine the amount that should be dug, we would figure as follows. Suppose the grower plants one acre of potatoes each year. It requires say 12 bushels of seed to plant this area. Then a multiplication plot of a quarter of an acre producing at the rate of 100 bushels per acre would furnish enough seed to plant the acre (12 bus.), replant another

multiplication plot of ¼ acre the following year, (3 bus.) and allow for the rejection of 10 bushels from the least productive hills. It will be necessary then in beginning the selection work for this grower to dig enough high yielding hills next fall to make three bushels of seed. The number that it will be necessary to dig will depend of course upon the productive power of the strain of seed he has been planting. It is best in making the initial selection to adopt as high a standard as possible.

Having dug the required amount for seed they should be stored carefully, kept at as cool a temperature and as dormant as possible until planting and then be planted just as one would plant his main crop. In the fall the multiplication plot should be dug by hand, and the hills kept separate. Those hills that are clearly inferior should be rejected. Then enough of the best hills should be selected to plant the multiplication plot of the next season. As many as are needed to plant the main crop should be selected next, and the balance sold or kept for home use. By following out this simple plan the grower should be able in a comparatively few years, to develop a high yielding strain of the variety which he plants.

In making his selection the grower should look for the hills which produce the largest number of smooth, uniformly medium sized tubers that are of typical shape for the variety being selected.

Marketing the Crop. The bulk of the crop in this state is allowed to mature before digging and is then sold directly from the field. Most of it is disposed of locally in small lots or if shipped in quantity is sent in bulk. This method of handling has the advantage of saving the cost of packages. It is probable that with the extension of the industry it will become necessary to adopt either the barrel or burlap sack holding eleven pecks or 165 pounds, the packages most generally used for this crop. Our growers will also find it profitable to give more attention to the proper grading of the crop. A potato sorter that will greatly facilitate the work of grading can be obtained from manufacturers or constructed at home.

The largest wholesalers or jobbers of produce in the large distributing centers are attracted to those points where the crops which they seek for their trade can be secured in dependable quantities that permit of shipment in car lots. Our potato growers should keep this fact in mind and wherever soil, market conditions and transportation facilities are favorable an effort should be made

to get as many as possible of the farmers in the community to grow potatoes of not more than two varieties in quantities enough to attract buyers. Contrary to the common belief among farmers that "if everybody goes to growing potatoes, we won't be able to give them away", the communites which have the least difficulty in disposing of the produce they raise are those which produce in quantities large enough to make them a factor in the market and attract buyers for their crops.

Storing the Crop. Taken one year with another it will probably pay our potato growers to sell the bulk of their crop as soon as it is mature. However, the necessary cost of storage could easily be covered in the added returns which might be obtained during a season when the ability to hold the crop made higher prices to the grower possible. In most sections of the state potatoes are kept in good condition by burying out of doors. When stored in quantity however it will be found more convenient to store in especially constructed cellars. These should preferably be under some of the farm buildings rather than under the dwelling as the temperature in the latter is apt to be too high for best results. In the southern part of the state at low elevations it will doubtless be found best to buy seed from the higher altitudes in the state where they can be kept dormant until needed, or else place it in cold storage.

The Experiment Station will send blue prints and specifications of a potato storage cellar to those requesting the same.